CLAIMS

1. An optical element, comprising:

a first layer of a first anisotropic material having a first surface, the first layer having a first optical index of refraction corresponding to a first internal axis and a second optical index of refraction corresponding to a second internal axis, the first and second indices being different; and

a second layer of a material different from the first anisotropic material and having a second surface in intimate contact with the first surface, the second layer having a third optical index of refraction that is a geometric mean of the first and second optical indices of refraction.

2. The optical element of claim 1 wherein the first internal axis and the second internal axis define a plane.

3. The optical element of claim1 wherein the first optical index of refraction is an ordinary index of refraction and the second optical index of refraction is an extraordinary index of refraction.

4. The optical element of claim 1 wherein the material different from the anisotropic material is an isotropic material.

5. The optical element of claim 4 wherein the second layer is an anisotropic material, further including a third layer of an isotropic material interposed between the first and second materials.

6. The optical element of claim 5 wherein the third layer has an index of refraction that has a geometric mean substantially equal to the geometric mean of the first and second optical indices of refraction.

7. The optical element of claim 4 wherein the material different from the first anisotropic material is rotated relative to the anisotropic material.

8. The optical element of claim 7 wherein the first and second materials are materials having principal material axes, and wherein the angle of rotation of the material different from the first anisotropic material relative to the first anisotropic material substantially satisfies the relationship:

$$\beta_1 \varepsilon_1{}^2 = \beta_2 \varepsilon_2{}^2$$

$$\sqrt{\beta_1}\cos^2\phi_1 + \frac{1}{\sqrt{\beta_1}}\sin^2\phi_1 = \sqrt{\beta_2}\cos^2\phi_2 + \frac{1}{\sqrt{\beta_2}}\sin^2\phi_2$$

where:

ε_1 is a dielectric constant of the first material relative to its principal material axis; ε_2 is a dielectric constant of the second material relative to its principal material axis;

$\beta_1\varepsilon_1$ is a dielectric constant of the first anisotropic material relative to a second material axis; $\beta_2\varepsilon_2$ is a dielectric constant of the second material relative to a second material axis; and

ϕ_1 is an orientation angle of the principal material axis of the first anisotropic material and ϕ_2 is an orientation angle of the principal material axis of the second material.

9. The optical element of claim 1 wherein the second layer includes a third surface, further including a third layer of a second anisotropic material in intimate contact with the third surface.

10. The optical device of claim 9 wherein the first and second anisotropic materials are the same type of material.

11. The optical device of claim 9 wherein the first and second anisotropic materials are different types of material.

12. The optical element of claim 9 wherein the anisotropic material in the third layer is oriented substantially identically with the anisotropic material in the first layer.

13. The optical element of claim 9 wherein the anisotropic material is a crystalline material having crystal planes.

14. The optical element of claim 1 wherein the geometric mean is the square root of the first optical index of refraction times the second optical index of refraction.

15. The optical element of claim 1 wherein the first layer of anisotropic material is a planar slab having parallel faces.

16. The optical element of claim 1 wherein the first layer of anisotropic material includes an input face configured to receive an optical beam.

17. The optical element of claim 16 wherein the input face is non-parallel relative to the first surface.

18. The optical element of claim 1 wherein the first surface includes a non-infinite radius of curvature.

19. An optical element, comprising:

a first portion having a first principal material axis with a first permittivity ε_1,and a second material axis with a second permittivity $\beta_1\varepsilon_1$;

a second portion in intimate contact with the first portion, the second portion having a second material axis and defining a two dimensional surface of incident contact and a

normal axis relative to the defined two dimensional surface, the second portion having a second principal axis, a first permittivity ε_2 and a second permittivity $\beta_2\varepsilon_2$;

wherein the permittivities satisfy the relationship:

$$\beta_1\varepsilon_1{}^2 = \beta_2\varepsilon_2{}^2$$

and the principal axis of the materials satisfy the relationship:

$$\sqrt{\beta_1}\cos^2\phi_1 + \frac{1}{\sqrt{\beta_1}}\sin^2\phi_1 = \sqrt{\beta_2}\cos^2\phi_2 + \frac{1}{\sqrt{\beta_2}}\sin^2\phi_2,$$

where ϕ_1 is an angle of the first principal material axis relative to the normal and ϕ_2 is an angle of the second principal axis relative to the normal.

20. The optical element of claim 19 wherein the defined surface is planar.

21. The optical element of claim 19 wherein the β_1 is substantially 1.

22. The optical element of claim 19 wherein β_2 is substantially 1.

23. The optical element of claim 19 wherein the first portion comprises an anisotropic crystal.

24. The optical element of claim 23 wherein the second portion comprises an anisotropic crystal.

25. A method of producing a refractive element, comprising:

identifying a first electromagnetic parameter of the first material corresponding to a selected first internal axis of the first material;

identifying a second electromagnetic parameter of the first material corresponding to a selected second internal axis of the first material, the second electromagnetic parameter being related to the first electromagnetic parameter by a ratio β_1;

identifying a first electromagnetic parameter of a second material corresponding to a selected first internal axis of the second material, the second material being a different material from the first material;

identifying a second electromagnetic parameter of the second material corresponding to a selected second internal axis of the second material, the second electromagnetic parameter of the second material being related to the first electromagnetic parameter of the second material by a ratio β_2, such that the ratio of the first electromagnetic parameter of the second material to the first electromagnetic parameter of the first material is equal to,

$$\sqrt{\frac{\beta_1}{\beta_2}}$$

determining an orientation of the second material relative to the first material at which reflected energy at a boundary between the first and second materials is substantially zero;

orienting the materials at the determined orientation; and

joining the materials at the determined orientation.

26. The method of claim 25 wherein the first electromagnetic parameter of the first material is a permittivity ε_1 of the first material and the first electromagnetic parameter of the second material is a permittivity ε_2 of the second material.

27. The method of claim 26 wherein the selected first internal axis of the first material is a principal axis of the material.

28. The method of claim 27 wherein the selected first internal axis of the first material is a principal axis of the material

29. The method of claim 28 wherein determining an orientation of the second material relative to the first material an angle at which reflected energy at a boundary between the first and second materials is substantially zero includes orienting the first material principal axis and second material principal axis according to the equation:

$$\sqrt{\beta_1}\cos^2\phi_1 + \frac{1}{\sqrt{\beta_1}}\sin^2\phi_1 = \sqrt{\beta_2}\cos^2\phi_2 + \frac{1}{\sqrt{\beta_2}}\sin^2\phi_2$$